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AUTHOR Fletcher, Richard K., Jr.
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ABSTRACT

Reports regarding enrollment in high school physics show that the number of students enrolled in physics increased until the late 1960's but the percentage enrollment in high school physics has dropped almost continuously. Some reasons for this are that physics courses are generally thought of as college preparatory curriculum and are sometimes directed at the few students who are interested in a college program in one of the sciences. Students enrolled in high school physics come from the upper portion of their classes. In addition, many of our practices and ideas suggest that physics is only for the elite. A physics curriculum, Project Physics, has been developed which does not rely as heavily on mathematics as do traditional courses and is suitable for sophomores. It is suggested that introduction of a course such as Project Physics for students who do not have the mathematical aptitude or are not interested in a career in science would be useful as an alternative to the traditional approach. (BB)

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DECLINING ENROLLMENT IN PHYSICS: WHAT CAN WE DO?

A Paper

by

Dr. Richard K. Fletcher, Jr.
Associate Professor
Department of Secondary Education & Foundations
Tennessee Technological University
Cookeville TN 38501

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Dr. Richard K. Fletcher, Jr.
Associate Professor
Secondary Education and Foundations
Tennessee Technological University
Cookeville, Tennessee 38501

What can be done to stem the decline in the percentage of high school students who enroll in physics, has been a recurring question since the beginning of this century. Though assessments have been made, the solutions offered have provided few positive results. This study was designed to offer some evidence for or against statements being made such as the following by Livermore:

. . . This sequence of courses has become established over several decades but there is no logical reason for teaching the courses in this order. Indeed, when one looks at the interrelationships of the disciplines, logic suggests that the order should be inverted. Modern biology requires of the student more than a speaking acquaintance with chemistry . . .¹

This question has been discussed in many circles. One of the chief arguments against offering physics at grade ten is that the mathematical background of students is inadequate.

The reports regarding enrollment in high school physics point to the fact that though the number of students enrolled in physics increased until the late 1960's, due to an overall increase in student population, the percentage enrollment in high school physics has dropped almost continuously.^{2,3}

¹Arthur H. Livermore, "Curriculum Research in Science," The Journal of Experimental Education, 37: 50, Fall, 1968.

²G. G. Mallinson, et al., "Final Report to the Central Association of Science and Mathematics Teachers of Its Committee on the Mathematics and Science in Education." School Science and Mathematics, 54:119-143, February, 1954.

³Fletcher G. Watson, "Why Do We Need More Physics Courses?" The Physics Teacher, 5:212-14, May, 1967.

There have been recommendations made for reversing the trend in enrollment but they have resulted in little actual change. Since 1950, the percentage of twelfth grade students enrolled in high school physics has dropped from over twenty-five percent to considerably less than twenty percent.⁴

The Project Physics course was developed with the very important goal of increasing enrollment in physics. The use of this approach has helped to halt the decline in enrollment where it has been used. Moore reports that enrollments approximately doubled in a three year period where the materials were used.⁵

The nature of the physics courses normally taught to high school students is possibly related to the enrollment problem for the course. Physics courses are generally considered as college preparatory curriculum. They are sometimes directed to the few who are interested in a college program in one of the sciences. In many cases the high school course is a miniature college physics course. Evidence shows that those who enroll in high school physics come from the upper portion of their classes having an average I.Q. of 115-120.^{6,7}

⁴ Ibid., p. 213.

⁵ Arnold J. Moore, "Harvard Project Physics - A Cogent Approach," Science Education, 52:343, October, 1968.

⁶ John S. Bila and Harold F. Bligh, "Physics Curriculum Patterns in High School," Science Education, 53:242, April, 1969.

⁷ Wayne W. Welch, "Some Characteristics of High School Physics Students: circa 1968," Journal of Research in Science Teaching, 6:244-245, No. 6, 1969.

A statement by Drozin clarifies one aspect of the enrollment problem and offers a suggested solution.

I attributed the continuous decline in percentage enrollment in physics in our high schools to the fact that physics is a very difficult and probably the most difficult of all the high school subjects . . .

The problem to increase enrollment in high school physics is therefore equivalent to the problem of how to make the high school course in physics a less difficult and more attractive one to all or at least to a majority of students.⁸

The population of physics classes is not only elite, it appears that many of our practices and ideas suggest that it is only for the elite. Grading policies and other unwritten stigmas result in attitudes toward the course which discourage student enrollment. Krieger studied the grades received by students in high school physics and chemistry and college chemistry. He found the following results:

The analysis of the high-school chemistry, high school physics, and college chemistry grades indicates that the high school student: (a) may expect to receive a college chemistry grade about three letter grades lower than his high school chemistry grade, (b) may expect to receive a college chemistry grade about the same as his high school physics grade (c) may expect to receive a college chemistry grade about two letter grades lower than the average of his high-school chemistry and physics grades.⁹

Krieger further concludes that:

. . . the most important result of this study is the recognition that A and B chemistry students are discouraged from taking physics because their physics grade will be lower by three letter grades. A re-evaluation of the testing devices is obviously necessary to make the grades more equitable. Perhaps this will reverse the trend of declining physics enrollments.¹⁰

⁸V. G. Drozin, "What Should be Done to Increase the Enrollment in Physics," The Physics Teacher, 4:23, January, 1966.

⁹Albert G. Krieger, "A Comparative Study of Grades Received by Students in Chemistry and Physics," School Science and Mathematics, 68:829-833, December, 1968.

¹⁰Ibid., p. 833.

Yale reached the following conclusions:

At least three reasons appear to stand out as basic to all of the ones furnished by science teachers and administrators for low enrollments in the physical sciences in high school. Dominant among these is insufficient previous preparation by students to be able to do well in these science courses. Possibly related to this is the reason that students tend to avoid the difficult subject in order that they may get good marks with least effort. That high school students are not receiving sufficient, positive advisement and encouragement to enroll in physical sciences is relevant of this problem. A fourth reason, although not mentioned by either the science teachers or the administrators, might well be the methods used together with the attitude of the teacher.¹¹

As a part of the evaluation for Harvard Project Physics, Bridgham and Welch studied the correlations between grading practices of thirty teachers and student dropout percentage. They conclude that:

. . . Although only one of the correlations was statistically significant, the pattern of correlations support the hypothesis that severity in grading is associated with diminished physics enrollments. Additional research planned specifically for the study of this problem is needed.¹²

Welch found that "expressed course satisfaction is significantly related to indications of success in the course" while "satisfaction with the physics course is negatively related to the perceived difficulty of physics."¹³ He states that "perhaps the most interesting finding is that it is almost impossible to predict the type of student likely to be satisfied in physics before the course started."¹⁴

¹¹F. G. Yale, "Why are High School Students Avoiding The Physical Sciences?", Science Education, 50:326, October, 1966.

¹²Robert G. Bridgham and Wayne W. Welch, "Physics Enrollments and Grading Practices," Journal of Research in Science Teaching, 6:46, No. 1, 1969.

¹³Wayne W. Welch, "Correlates of Course Satisfaction in High School Physics," Journal of Research in Science Teaching, 6:56, No. 1, 1969.

¹⁴Ibid., p. 57.

A formal investigation of 48 schools and 51 physics teachers in the State of Michigan was conducted by Van Koevering. These schools were chosen because they had either a high or a low percentage enrollment in physics. The one significant finding was as follows:

In high schools with high percentage enrollments in physics 90 percent of the physics teachers and 65 percent of the guidance counselors indicated that geometry or less was a sufficient mathematics prerequisite for physics. However, in high schools with low percentage enrollments in physics 68% of the physics teachers but only 25% of the guidance counselors indicated geometry or less was a sufficient prerequisite for physics.¹⁵

Fletcher * compared tenth, eleventh, and twelfth grade students enrolled in the Project Physics course in four schools in Virginia. He found that the achievement of tenth graders was significantly lower than their eleventh and twelfth grade counterparts. However, when mathematical and physics background were covaried the results were not statistically significant. The grade distributions of the 207 students are shown in the following table.

GRADES RECEIVED BY STUDENTS IN THE PROJECT
PHYSICS COURSE FROM FOUR SCHOOLS

A	B	C	D	F	GPA For Physics	No. of Students	Grade Level
8	26	26	4	0	2.59	64	10
15	14	14	4	1	2.79	48	11
30	32	28	3	2	2.89	95	12
53	72	48	11	3	2.78	207	Total

¹⁵ Thomas E. Van Koevering, "The Distinguishing Characteristics of High Schools with High and Low Enrollments in Physics," Journal of Research in Science Teaching, 8:37-38, No. 1, 1971.

* These results are based on the writer's dissertation.
Richard K. Fletcher, Jr., "The Effects of Grade Level and Other Factors on the Achievement in Project Physics Among High School Physics Students." (University of Virginia, Charlottesville, 1971)

The grade point average in the Project Physics course was lower for the tenth grade students than for each of the eleventh and twelfth grade groups. The t-test results showed the differences to be statistically significant.

A questionnaire was mailed to the four teachers who had taught the Project Physics course. The reactions to some of the items from the questionnaire are listed below. When asked if they would have any hesitancy in enrolling tenth grade students in the same course for another year, two of the four teachers answered no and two indicated that selected sophomores would be preferred. One of these indicated that sophomores are taxed intellectually by the course but that they should definitely be given the chance to take physics.

Other comments made by the teachers were generally favorable toward teaching the course to tenth grade students. All of the four school districts registered sophomores in the Project Physics course for the 1972-73 academic year. One teacher indicated that almost all of the sophomores were glad they had taken physics in the sophomore year and planned to enroll in chemistry the next year.

Students from each of the three grade levels made lower grades in the Project Physics course than they had previously made in other science courses. The sophomore group dropped from a grade point average of 2.87 for previous science courses to a grade point average of 2.47 for the physics course. This difference is significant at the 0.01 level of confidence. The junior group dropped from a grade point average in science of 2.97 to a grade point average

in the Project Physics course of 2.68 not significantly different at the 0.05 level of confidence. The senior group dropped from 2.66 to 2.63 not significant at the 0.05 level of confidence.

Mathematical background as a prerequisite to success in high school physics is a generally accepted requirement. The author has determined that the Pearson product-moment correlation between achievement test scores in the Project Physics course and achievement in mathematics as measured by the combined scores from Algebra I and Algebra II Cooperative Mathematics Tests was 0.66, highest of all the individual predictors. When one considers the generally lower mathematical emphasis in the Project Physics course than in other more difficult programs, it can be concluded that mathematical background is significantly related to success in high school physics. However, many high schools are teaching the second year algebra in grade ten and others have developed programs where students with mathematical ability are scheduled into algebra I in grade eight. This author recommends that students in grade ten who have demonstrated proficiency in algebra I and who are pursuing further study in algebra II be invited to enroll in the Project Physics course.

Since the completion of the dissertation in 1971, it is the observation of the author that much more emphasis is now being placed on the physical sciences in grades eight and nine with some exemplary programs such as ISCS placing emphasis on physical science concepts in grade seven. What the effects of these curricular changes means in terms of predicted success in high school

physics may be a topic worthy of investigation. Perhaps a study which compared students in grade ten with those in grades eleven and twelve would show less difference than was evident in 1971.

The author offers the following suggestions regarding potential areas for improving the enrollments in high school physics.

these are in order of importance:

1. There is a need to develop and introduce a two track system in both high school physics and high school chemistry. One of the programs should be labeled as general education while the other should be much more mathematically sophisticated and definitely for those students who plan to enter careers in science or engineering. Students in grade ten should be allowed to take the general program and enroll in the other program during their junior and senior years. Tenth grade students who demonstrate unusual progress in science and mathematics should be enrolled in the chemistry or physics sections scheduled for college preparatory students.
2. Teachers of chemistry and physics should remove any thoughts they may verbally or nonverbally transmit which demonstrates arrogance or elitism. They should work to educate the counselors in their schools so all capable students will know that chemistry and physics in some form is available to them. The practicality of these sciences is unquestioned when one considers their application in this scientific age.
3. Teachers may find that the difficulty levels of their tests are much higher since much of the content demands emphasis on the higher cognitive levels. The application of scores derived from such tests should not be forced to fit into school grading scales which assume a high level of low cognitive level items.

This paper offers a mixture of factual and opinionated information which the writer feels is important. This is especially true when one considers the dismal state of the percentage of enrollment in high school physics. The problem deserves immediate attention if physics is to survive as a viable offering in many high schools. In fact, it has been deleted from many offerings and the trend is set for even greater neglect of the subject.